Woods Hole Oceanographic Institution
Woods Hole, MA 02543 USA
Phone: (508) 457-2000
Fax: (508) 457-2169
Telex: 951679

Department of Biology

July 23, 1997

Dr. Robert Gisiner
Biological & Biomedical S&T Division
ONR, 800 N. Quincy Street
Ballston Tower One
Arlington, VA 22217-5660

Dear Dr. Gisiner:

On behalf of Dr. Peter L. Tyack, please find enclosed the original and two copies of the final report for ONR AASERT Grant N00014-94-1-0892.

Please let me know if there is anything further which you require.

Sincerely,

Jane E. Marsh
Senior Staff Assistant
Biology Department
jmarsh@whoi.edu

enclosures

xc: ONR, Boston (1 copy of Form 298)
NRL (1 copy of report)
DTIC (2 copies of report) ✓
ONR, AASERT/92 (1 copy of URI/AASERT feport form A2-2)
S. Ferreira, WHOI Grant & Contract Services (1 copy report)

AUGMENTATION AWARDS FOR SCIENCE AND ENGINEERING, RESEARCH TRAINING, (AASERT) REPORTING FORM

The Department of Defense(DOD) requires certain information to evaluate the effectiveness of the AASERT program. By accepting this Grant, which bestows the AASERT funds, the Grantee agrees to provide the information requested below to the Government's technical point of contact by each annual anniversary of the AASERT award date.

1. Grantee identification data: (R & T and Grant numbers found on Page 1 of Grant)

   a. University Name: Woods Hole Oceanographic Institution

   b. Grant Number: N00014-94-1-0892 c. PR Number: 3412aas08

   d. P.I. Name: Peter L. Tyack e. From: 6/1/96 - 5/31/97 (AASERT Reporting Period)

NOTE: Grant to which AASERT award is attached is referred as "Parent Agreement."

2. Total funding of the Parent Agreement and the number of full-time equivalent graduate students (FTEGS) supported by the Parent Agreement during the 12-month period prior to the AASERT award date.

   a. TOTAL: $0 Parent Grant No. N00014-92-J-1816

   TOTAL PROJECT PERIOD: 5/15/92 - 6/30/94

   b. Number FTEGS: 0

3. Total funding of the Parent Agreement and the number of FTEGS supported by the Parent Agreement during the current 12-month reporting period.

   a. TOTAL: 0

   b. Number FTEGS: 0

4. Total AASERT funding and the number of FTEGS and undergraduate students (UGS) supported by AASERT funds during the current 12-month period.

   a. $110,144 Total Award $29,376 Year Three Period: 6/1/96 - 5/31/97

   b. Number FTEGS: One

   c. Number UGS: 0

VERIFICATION STATEMENT: I hereby verify that all students supported by the AASERT award are U.S. Citizens:

Peter L. Tyack Date: 14 July 1997

Peter L. Tyack

Report for Grant Number N00014-94-1-0892

For the project Fusion of Acoustic and Visual Observations of Marine Mammals we conducted three field seasons in two locations and Nowacek spent non-field season time either in classes at MIT/WHOI or conducting laboratory work at WHOI. The majority of the field work occurred in the Sarasota Bay, FL area with bottlenose dolphins, Tursiops truncatus, being the focal species. A smaller amount of field work was conducted in the Haro Strait, WA area with the focus on the killer whale, Orcinus orca.

Overhead Video System

This system utilizes a small helium filled aerostat (30 m3) to suspend a video camera which is outfitted with an 10x zoom lens and pan/tilt capabilities. Camera angle, focus, iris aperture, and zoom are adjusted while watching a video monitor on the boat and the footage is recorded either on Beta SO or Hi-8. Two tethers run from the boat to the aerostat: the strength cord which anchors the aerostat to the boat and the electrical tether which carries power and control to the camera and video from the camera to the boat. After coming from the camera the video is patched directly into the recorder then to the monitor. The audio signals are fed through a high pass filter (-3dB point = 4 kHz) then into the recorder, and audio levels and quality are monitored with headphones. The iterations of the system are described below in the research time line.

Research Time Line

15 May-31 July, 1995, Sarasota, FL: The overhead video was deployed and used for approximately six weeks during which time we also attempted unsuccessfully to deploy a towed hydrophone array, although acoustic data were collected using a simpler system. The overhead video system was used successfully to collect pilot data for Nowacek's thesis proposal. The system at that time included a Panasonic integrated pan-tilt-zoom camera the video signal from which was monitored and recorded on the boat. A Sony BVW-30 recording deck was used to record both video and the small amount of audio recordings obtained. The video recordings obtained included a dolphin successfully capturing a fish as well as approximately 20 hours of other dolphin behavior.

1 Aug.-20 Aug., Santa Cruz, CA: Nowacek attended a bioacoustical oceanography workshop at the University of California at Santa Cruz. 21-31 Aug., Haro Strait, WA: We deployed the overhead video system in the area of the San Juan Islands, and obtained footage of killer whales as well as opportunistic recordings of Dales and harbor porpoises. The footage included a segment with a mother and calf killer whale during which time a putative nursing bout occurred. In addition we obtained footage showing the effectiveness of the overhead video for studying inter-animal spacing and movement patterns which both will be important when fused with the sound-localizing hydrophone array developed by Miller & Tyack (1997).

1 Sept., 1995-31 May, 1996, Woods Hole, MA: Nowacek attended classes, analyzed the footage obtained, and made preparations for the 1996 field season. In December, 1995, Nowacek presented a poster (Nowacek et al. 1995) at the XI Biennial Conference on the Biology of Marine

Mammals reporting the progress attained with the overhead video system.

1 June-30 Sept., 1996, Sarasota, FL: The overhead video system was again used to film the behavior of free-ranging bottlenose dolphins. During this deployment we used a new camera, a Burle integrated pan-tilt-zoom, which allows for much more rapid movement of the camera so as to maintain visual contact with the animals for longer periods. In addition, the Burle has the ability to continuously pan through 3600 eight times which also facilitates maintaining visual contact with the animals. To obtain high quality continuous acoustic recordings we utilized a system similar to that used by Sayigh et al. (1993). While this system consists of only two channels instead of an array of many sensors, it provides a reliable means of obtaining quality recordings while underway. A total of 75 boat days were completed during this field season; weekends are not workable due to the large number of boats on the water. We successfully video taped 12 feeding sequences as well as approximately 80 additional hours of dolphin behavior.

1 Oct., 1996-30 April, 1997, Woods Hole, MA: Nowacek continued analyses of the overhead video and acoustic data, began writing a manuscript reporting the use of the acoustic/video system (Nowacek et al., in prep), and designed, developed, and built an acoustic data logger to be used in concert with the overhead video/audio system in June, 1997. The video data have shown new behaviors not before reported for the Sarasota dolphins, and elucidated functions of previously described behaviors. The matching acoustic data, while not providing any new sounds, have revealed new information regarding the functions of some sounds.

May, 1997, Sarasota, FL: Nowacek returned to continue his field work, and for two weeks in May he conducted a feasibility study using the overhead video/audio system to study manatees. While not in the original proposal, manatees can be studied effectively with this system, and this pilot study showed that individual identifications and approximate sizes of manatees can be obtained from the overhead video data. During the end of May Nowacek made final preparations for the June project to combine the overhead video/audio system with the acoustic data logger. In addition, Nowacek plans to continue his study using the video/audio system throughout the summer of 1997, and in the fall to fuse it with the Miller & Tyack (1997) acoustic array.

Summary

The system developed under grant number N00014-94-1-0892 has proven to be very effective for collecting continuous acoustic and behavioral data of marine mammals. The system has been utilized and provided valuable data in three distinct research contexts. Studying the behavior of marine mammals is confounded by the fact that they spend very little time at the surface, and in many environments this means that they are visible for only a small percentage of the observation time. Modern behavioral research techniques require continuous observations of animals for periods of tens of minutes, and this overhead video system provides this ability in many situations. When fused with simultaneous acoustic recordings it produces data that enable researchers to explore previously unapproachable questions.

References

Miller PJ and PL Tyack (in press) A small towed beamforming array to identify resident killer whales (Orcinus orca) concurrent with focal behavioral observations. Deep-Sea Research.

Nowacek, Douglas P; Lange, William N; Wells, Randall S; Tyack, Peter L (1995): A new method for studying cetacean behavior and acoustics: overhead video combined with underwater audio. Eleventh Biennial Conference on the Biology of Marine Mammals, December 14-18, Orlando, FL.

Nowacek, D.P.; Wells, R.S.; Tyack, P.L. A mobile overhead video system for observation and recording of marine mammal behavior. Manuscript in prep.

Sayigh, L.S.; Tyack, P.L.; Wells, R.S. 1993. Recording underwater sounds of free-ranging dolphins while underway in a small boat. Mar. Mam. Sci. 9(2):209-213.

REPORT DOCUMENTATION PAGE

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FUSION OF ACOUSTIC AND VISUAL OBSERVATIONS OF MARINE MAMMALS

5. FUNDING NUMBERS
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6. AUTHOR(S)
PETER L. TYACK

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
MAIL STOP 34, BIOLOGY DEPARTMENT
WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MA 02543

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13. ABSTRACT *(Maximum 200 words)*

We have developed and implemented a mobile marine mammal observation platform that combines overhead video with underwater acoustic recording. Modern behavioral sampling techniques require continuous observation of animals for extended periods. Such sampling of marine mammals is difficult due to the small amount of time they spend at the surface and, in many environments, the limited ability to see into the water. The overhead video system permits us to maintain visual contact with animals when they are below the surface, and in some situations throughout the water column. The underwater acoustic recording system allows us to obtain high quality recordings while the boat is underway. The fused system has been used primarily for Nowacek's thesis research on bottlenose dolphins. The overhead video system has also been used to study killer whales, and a more extensive acoustic system will be fused with the overhead video this fall as the killer whale research continues. The bottlenose dolphin research has produced novel behavioral and acoustic data. From the video footage we have described behaviors not previously reported, and elucidated functions of poorly understood behaviors. The simultaneous acoustic data suggest specific functions for some sounds.

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